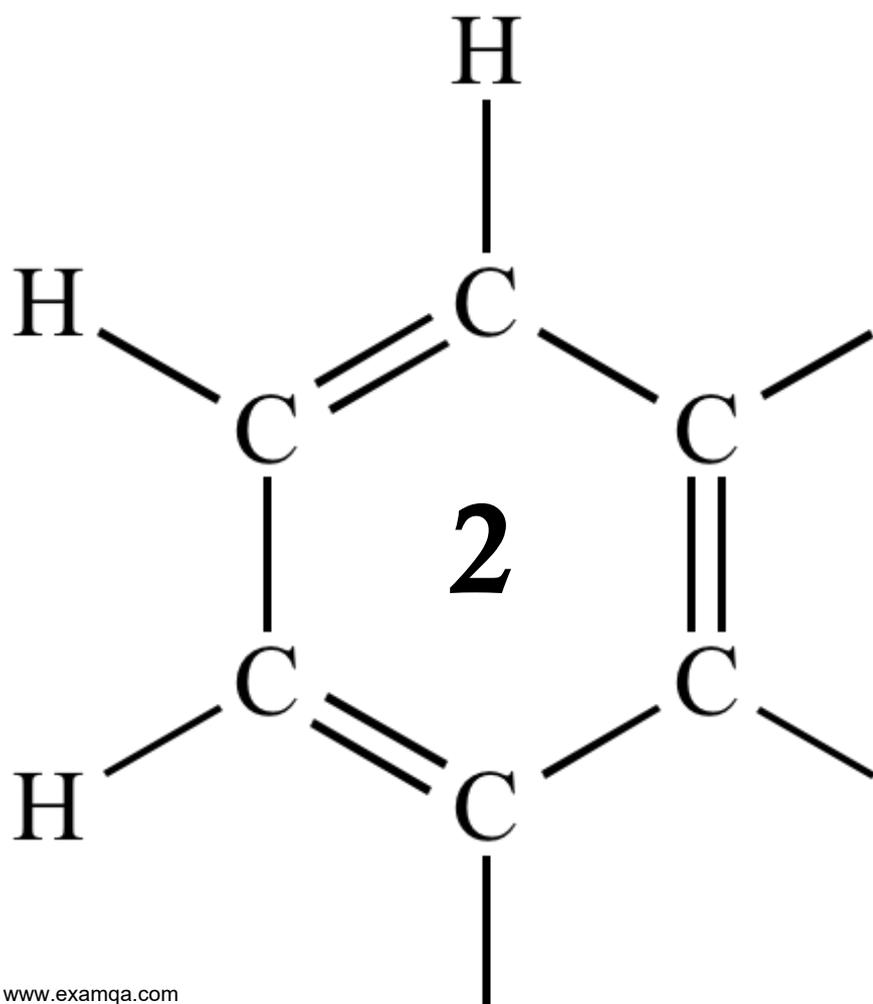


AQA A2 CHEMISTRY
ISOMERISM ~ CARBONYLS

OPTICAL ISOMERS



1 Which one of the following reactions will produce an organic compound that has optical isomers?

- A** dehydration of butan-2-ol by heating with concentrated sulphuric acid
- B** reduction of pentan-3-one by warming with NaBH_4
- C** addition of Br_2 to 3-bromopropene
- D** reduction of 2,3-dimethylpent-2-ene with H_2 in the presence of a nickel catalyst

(Total 1 mark)

2 Each of the parts (a) to (e) below concerns a different pair of isomers.

Draw one possible structure for each of the species **A** to **J**, using Table 2 on the Data Sheet where appropriate.

- (a) Compounds **A** and **B** have the molecular formula C_5H_{10}
A decolourises bromine water but **B** does not.

A **B**

(2)

- (b) Compounds **C** and **D** have the molecular formula $\text{C}_2\text{H}_4\text{O}_2$

Each has an absorption in its infra-red spectrum at about 1700 cm^{-1} but only **D** has a broad absorption at 3350 cm^{-1}

C **D**

(2)

(c) Compounds **E** and **F** are esters with the molecular formula $C_5H_{10}O_2$

The proton n.m.r. spectrum of **E** consists of two singlets only whereas that of **F** consists of two quartets and two triplets.

E **F**

(2)

(d) Compounds **G** and **H** have the molecular formula $C_3H_6Cl_2$ **G** shows optical activity but **H** does not.

G **H**

(2)

(e) Compounds **I** and **J** have the molecular formula C_6H_{12}

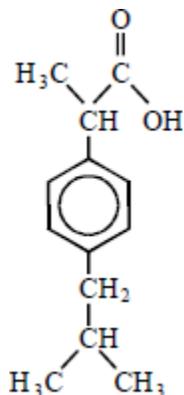
Each has an absorption in its infra-red spectrum at about 1650 cm^{-1} and neither shows geometrical isomerism. The proton n.m.r. spectrum of **I** consists of a singlet only whereas that of **J** consists of a singlet, a triplet and a quartet.

I **J**

(2)
(Total 10 marks)

3

Ibuprofen is a drug used as an alternative to aspirin for the relief of pain, fever and inflammation. The structure of ibuprofen is shown below.



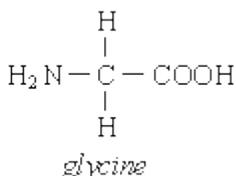
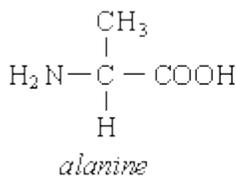
Which one of the following statements is **not** correct?

- A It has optical isomers.
- B It liberates carbon dioxide with sodium carbonate solution.
- D It undergoes esterification with ethanol.
- D It undergoes oxidation with acidified potassium dichromate(VI).

(Total 1 mark)

4

The structures of the amino acids *alanine* and *glycine* are shown below.



(a) Give the systematic name for *alanine*.

.....

(1)

(b) *Alanine* exists as a pair of stereoisomers.

(i) Explain the meaning of the term *stereoisomers*.

.....
.....
.....

(ii) State how you could distinguish between the stereoisomers.

.....
.....
.....

(4)

(c) Give the structural formula of the species formed by *glycine* at pH 14.

(1)

(d) When two amino acids react together, a dipeptide is formed. Give the structural formulae of the **two** dipeptides which are formed when *alanine* and *glycine* react together.

Dipeptide 1

Dipeptide 2

(2)

- (e) Give the structural formula of the organic compound formed when *glycine* reacts with methanol in the presence of a small amount of concentrated sulphuric acid.

(1)
(Total 9 marks)

5

Which one of the following statements about but-2-enal, $\text{CH}_3\text{CH}=\text{CHCHO}$, is **not** true?

- A** It has stereoisomers.
- B** It shows a strong absorption in the infra-red at about 1700 cm^{-1} .
- C** It will turn an acidified solution of potassium dichromate(VI) green.
- D** It can be dehydrated by concentrated sulphuric acid.

(Total 1 mark)

6

(a) **P**, **Q** and **R** have the molecular formula C_6H_{12}

All three are branched-chain molecules and none is cyclic.

P can represent a pair of optical isomers.

Q can represent a pair of geometrical isomers.

R can represent another pair of geometrical isomers different from **Q**.

Draw one possible structure for one of the isomers of each of **P**, **Q** and **R**.

Structure of **P**

Structure of **Q**

Structure of **R**

(3)

(b) Butanone reacts with reagent **S** to form compound **T** which exists as a racemic mixture. Dehydration of **T** forms **U**, C_5H_7N , which can represent a pair of geometrical isomers.

(i) State the meaning of the term *racemic mixture* and suggest why such a mixture is formed in this reaction.

Racemic mixture

.....

Explanation.....

.....

.....

- (ii) Identify reagent **S**, and draw a structural formula for each of **T** and **U**.

Reagent **S**

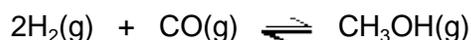
Compound **T**

Compound **U**

(6)
(Total 9 marks)

7

Hydrogen and carbon monoxide were mixed in a 2:1 mole ratio. The mixture was allowed to reach equilibrium according to the following equation at a fixed temperature and a total pressure of 1.75×10^4 kPa.



- (a) The equilibrium mixture contained 0.430 mol of carbon monoxide and 0.0850 mol of methanol.

- (i) Calculate the number of moles of hydrogen present in the equilibrium mixture.

.....

- (ii) Hence calculate the mole fraction of hydrogen in the equilibrium mixture.

.....

.....

.....

- (iii) Calculate the partial pressure of hydrogen in the equilibrium mixture.

.....

.....

.....

(5)

(b) In a different mixture of the three gases at equilibrium, the partial pressure of carbon monoxide was 7550 kPa, the partial pressure of hydrogen was 12300 kPa and the partial pressure of methanol was 2710 kPa.

(i) Write an expression for the equilibrium constant, K_p , for this reaction.

.....

(ii) Calculate the value of the equilibrium constant, K_p , for the reaction under these conditions and state its units.

K_p

.....

Units

(3)

(c) Two isomeric esters **E** and **F** formed from methanol have the molecular formula $C_6H_{12}O_2$

Isomer **E** has only 2 singlet peaks in its proton n.m.r. spectrum.

Isomer **F** is optically active.

Draw the structures of these two isomers.

Isomer E

Isomer F

(2)
(Total 10 marks)

8

On reduction, a racemate can be formed by

- A $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CHO}$
- B $\text{CH}_3\text{CH}_2\text{CH}_2\text{COCH}_3$
- C $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$
- D $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CHO}$

(Total 1 mark)

9

Which one of the following reaction mixtures would give a product capable of exhibiting optical isomerism?

- A $\text{CH}_3\text{CH}=\text{CH}_2$ + HBr
- B $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$ + NaOH
- C $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ + H_2SO_4
- D $\text{CH}_3\text{CH}_2\text{CHO}$ + HCN

(Total 1 mark)